Workshop Session #3:

Human Interaction with Embedded Virtual Simulations

Summary of Discussion

This workshop session was facilitated by Dr. Thomas Alexander (GER) and Dr. Sylvain Hourlier (FRA) and focused on interface technology and human effectiveness including sensors and controls, visual perception and decision making (e.g. target detection and identification) within EVS. Four papers related to EVS interface technology were developed and three were presented; Dr. Godroy was unable to attend due to illness.

- *Embedded Augmented Reality Training System for Dynamic Human-Robot Cooperation* Jan A. Neuhöfer, Dipl.-Ing. (GER); Bernhard Kausch, Dr.-Ing. (GER); and Christopher M. Schlick, Prof.-Ing. (GER), Institute of Industrial Engineering and Ergonomics, Aachen University

- *Human Dimensions in Multimodal Wearable Virtual Simulators for Extra Vehicular Activities* - Martine Godfroy, Ph.D. (FRA/USA), NASA Ames Research Center/ San Jose State University)

- *Embedded Training in a Ground Soldier System*- Jean Dyer, Ph.D. (USA), U.S. Army Research Institute for the Behavioral and Social Sciences

- *Interaction between Reference Frames: a concern in embedded training* -Patrick Sandor, M.D., Ph.D. (FRA), IRBA; D. Hartnagel, Ph.D. (FRA), IRBA; L. Bringoux, Ph.D. (FRA), ISM; C. Bourdin, Ph.D. (FRA), ISM; M. Godfroy, Ph.D. (FRA/USA), NASA Ames Research Center/ San Jose State University; C. Roumes, M.D., Ph.D. (FRA), IRBA

Workshop Exercise #3: ***Mindmapping EVS interface technology***

For this session, the mindmapping exercise focused on EVS interface technology and the question below was intended to focus and energize the discussion:

- What are the capabilities and limitations of embedded virtual simulation interface technology?

The mindmaps shown below are the group products from Exercise #3 on EVS interface technology. Note that the mindmap for Group 1 is missing:

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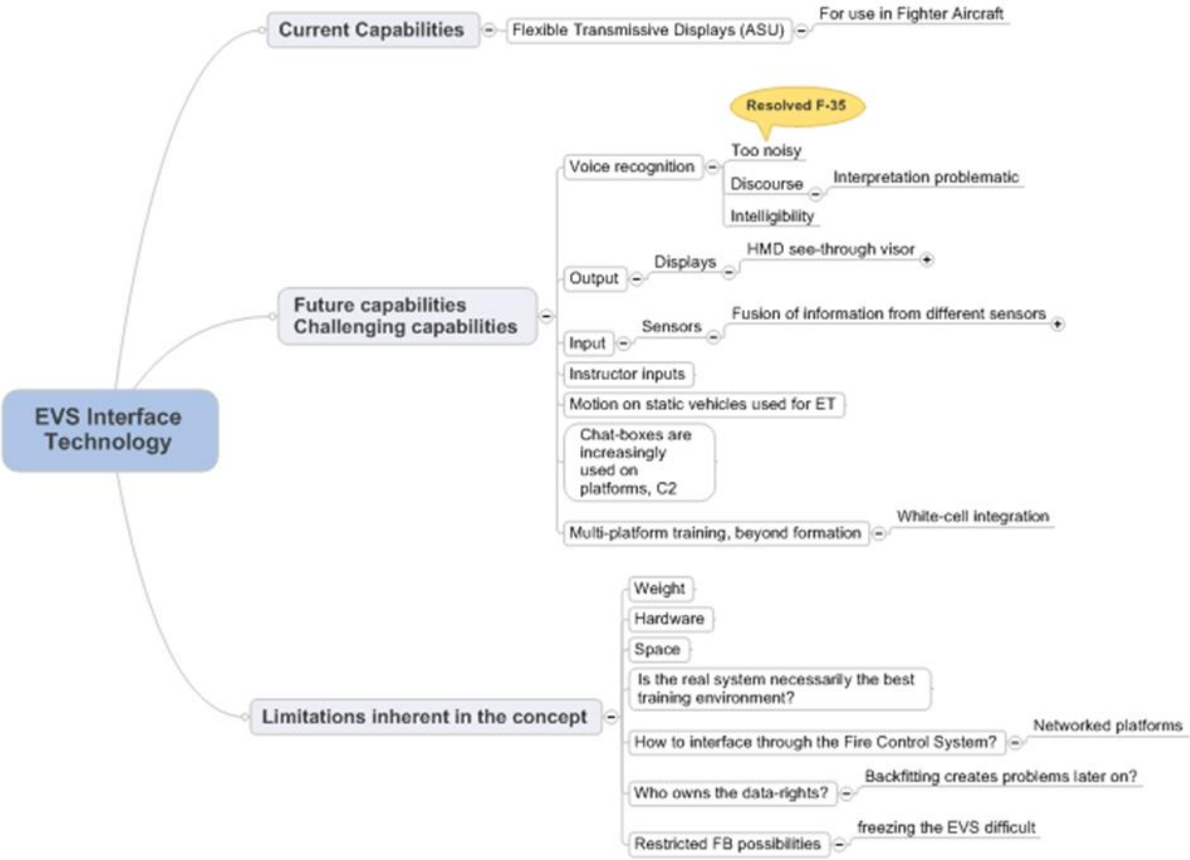

Figure 1: Group 2 Mindmap for Exercise #3

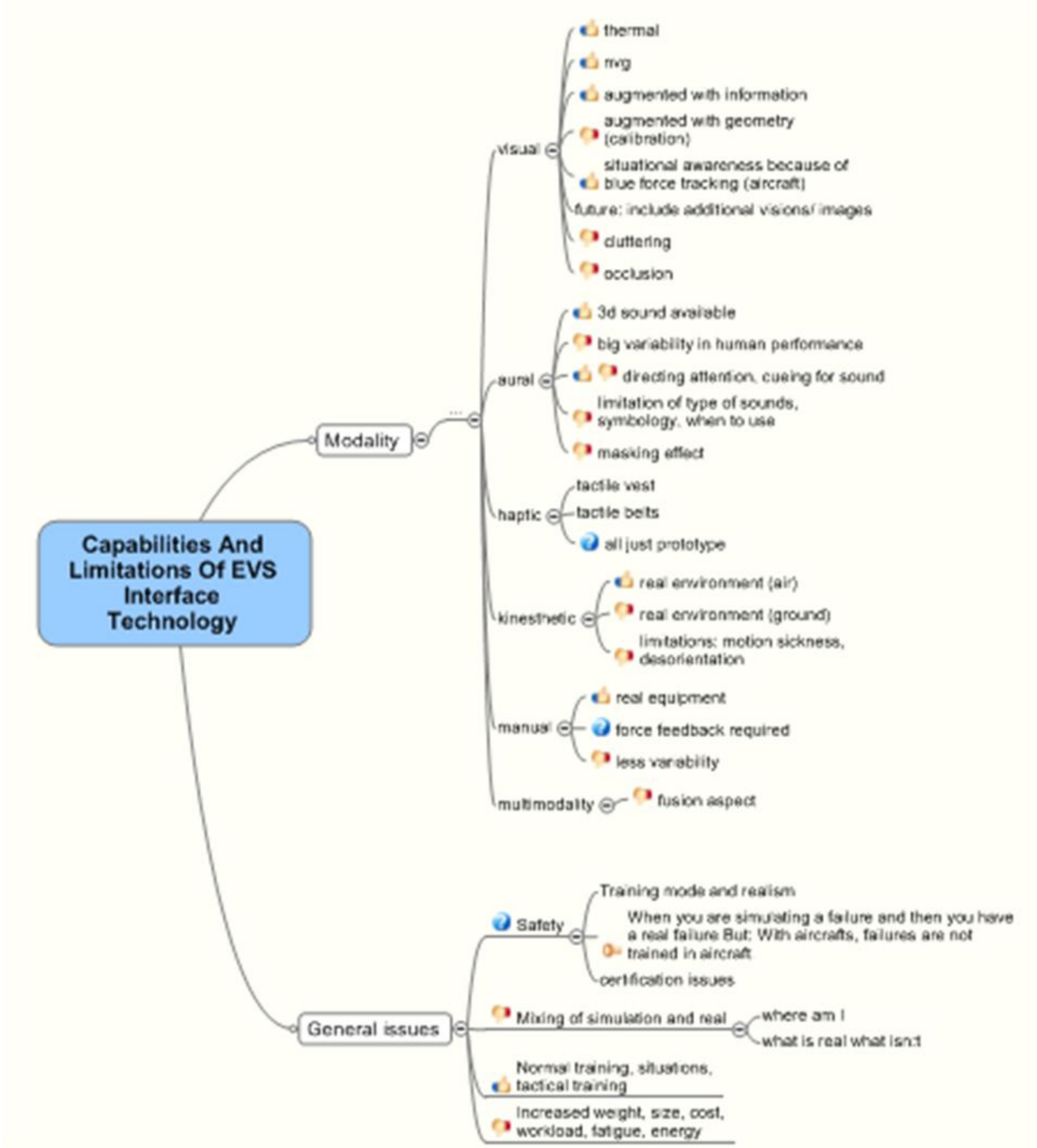

Figure 2: Group 3 Mindmap for Exercise #3

There are just two mindmaps available (check if the others have the missing ones). They differ from each other at a basic level. MM1 is more conceptual and addresses capabilities and limitations of EVS interface technology. On the other hand, MM2 addressed special issues of each modality for i/o interfaces and several more general issues with EVS interface technology.

The first map starts with addressing some of the current capabilities which are already available. An example for this technology is the development of flexible transparent displays, which can be used for fighter aircrafts.

The second category is future capabilities, which have to be addresses although they are challenging. They focus particular voice recognition, problems of information output and input technology and issues for special applications. Voice recognition is such a challenging topic because some applications (e.g. aerospace applications) are characterized by a noisy environment. This can be partly resolved, e.g. as it has happened in case of the F35. Furthermore, discourse might lead to wrong interpretations. Finally there is the intelligibility. With regard to the output of information, some issues with visual displays were addressed as an example. In case of aerospace applications, an HMD-like see-through display would be first choice. In case, training includes visual tasks, simulated, computer-generated forces have to be visualized on the HMD. From a technical point of view, this puts high demands on the head tracking to allow correct angular velocity of the targets for a consistent information display.

Input technology requires new types of sensors and of sensor-data fusion. Sensor images have to be consistant to establish a realistic correspondence between each other. Some more general issues which have to be addressed with future challenges are capabilities for instructor input. An EVS system has to facilitate instructors input throughout training. This raised the issue of connecting multiple platforms with each other and integrating white-cell personnel on a technical level. Another more general issue addressed the simulation of motion with a static vehicle. Yet, motion is only induced by visual means, which might result into negative effect, e.g. motion sichness. Participants noted that, especially on C2 systems, chat boxes are increasingly used. It might help to include Web 2.0 methods and technologies to include the same into training systems. This will enhance interaction and communication between trainer and trainees. However, it is unclear how this can be included into the EVS concept.

The third category addresses limitations inherent to the concept of EVS which cannot be resolved. The address more general issues of EVS. In addition to technical problems with the integration of EVS hardware into existing systems, i.e. weight and dimensions, it is unclear whether the real system is always the best training system. This might be true for some phases of training, but not necessarily for every phase. Therefore, EVS should be considered as a part of education and training, which extends traditional training and does not replace it. It is still unclear, how EVS can be integrated into existing platforms, because they are sometimes highly modular with no general, common interface or bus system. E.g. the fire control system is often not connected to the weapon system and has to be operated manually. In this case, EVS cannot be consistently integrated. Another general issue is the legal issue of the EVS system and the database. It is unclear, if the fully embedded EVS can be fully integrated into the operational system when the operational system is already fielded. Therefore, options of straped-on EVS have to be considered accordingly.

With regard to limitations and capabilites, the second mindmap differentiates between the modalities of displays and input interfaces.

With regard to the modality of the display, most information is perceived by the visual modality. There are various displays in operation already, which allows integrating synthetic additional visual information into the sight. Examples of these are thermal or night-vision displays. They present additional information which is different from reality sight. Technologies from the field of Augmented Reality (AR) facilitate the integration of additional information into real sight. But yet, the consistent integration of geometric information into the sight is a problem because of occlusion and cluttering with reality. It might also require a complex calibration of the EVS system’s components and displays. But such displays are not limited to EVS, instead they might also be used to support the soldier during mission execution because they can also be used to present blue and red forces. Thus, the technology is not stand-alone but cross-application.

There are also capabilities of presenting EVS information through the aural modality. Today, 3D sound is widely available, which facilitates a realistic simulation of the aural environment. But there is a large variability of human performance. This might limit the applicability of sound in EVS systems. The aural modality can be used to direct (and, thus, control) attention. At this point, it is unclear which types of sound to use and how to specify aural symbology. Research is required in this field to use it successfully.

First haptic displays are currently being analyzed and examined for various purposes. Examples are various tactile vests and tactile belts, which can be used to display symbolic (haptic icons) and directional information. However, these prototypes are still topic of research and it is unclear how they can be used within EVS systems.

The relevance of the kinesthetic modality differs from each other between applications. Kinesthetic simulation requires a relatively large investment and special technology. For aerospace operations it is considered to be important, while ground operations vastly require kinesthetic cues. Cross application it is important that kinesthetic cues, either available or not, has limitations and might induce negative side-effects like disorientation or motion sickness.

Input interfaces often require special sensor technologies, which are not always available today. This is critical when operator actions have to be captured, e.g. head movements for a consistent display of geometric information. The benefit of EVS is that it can widely rely on the existing technology and available controls of the operational platform. This limits variability, but enhances realism and reality of the training environment. An open issue is the integration of feedback. E.g. force feedback requires additional technology which is connected to the real controls.

It is obvious, that the use of multi-modal information presentation requires a careful integration of each display in order to prevent a cue conflict and following negative side-effects.

The second category of the mindmap raises open questions about general issues. A very important one is safety. In addition to certification issues, the overlap between simulation and reality is minimized. In an ideal EVS system, the soldier will not be able to tell the difference between both. Thus, it is unclear if a failure is simulation or real. Unlike in traditional simulation, EVS has to include a method to present and to remind the soldier on the mode the system is in. The soldier has to be aware what is real and what is simulated, otherwise dangerous situation might appear. This is especially crucial for aerospace operations with high g-loads. EVS cannot be considered as one solution for each application, instead EVS can serve as a method and means at special phases of training. Integration of EVS always requires a close consideration of its benefits, because it comes with costs of increased weight, size, costs, workload, fatigue and energy. However, because some of its capabilities might be used for other purposes than training as well (e.g. augmented reality).